Harnessing Coulombic Interactions to Prepare High-Quality Colloidal Crystals

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Self-assembly of inorganic nanoparticles (NPs) into ordered structures ("superlattices") has led to a wide range of nanomaterials with unique optical, electronic, and catalytic properties. Various interactions have been employed to direct the crystallization of NPs, including van der Waals forces, hydrogen bonding, as well as electric and magnetic dipolar interactions [1]. Among them, Coulombic interactions have remained largely unexplored, owing to the rapid charge ligand exchange between NPs bearing high densities of opposite charges. In this talk, I will describe a new method [2] to assemble these "superionic NPs" under conditions that preserve their native surface charge density. Our methodology was used to assemble oppositely charged NPs into high-quality superlattices exhibiting Catalan shapes [3]. The methodology can be applied to a wide range of charged nanoparticles of various sizes, shapes, and compositions. I will also discuss different ways to employ electrostatic interactions to assemble NPs into transient assemblies [2,4], whose lifetimes depend on and can be controlled by the availability of small-molecule ionic "fuels".

[1] M. A. Boles, M. Engel, D. V. Talapin, *Chem. Rev*. **2016**, *116*, 11220–11289.

[2] T. Bian *et al.*, *Nat. Chem.* **2021**, *13*, 940–949.

[3] T. Bian *et al. ChemRxiv* **2022** 10.26434/chemrxiv-2022-klncg.

[4] J. Wang, T. S. Peled, R. Klajn, *J. Am. Chem. Soc.*, **2023**, 145, 4098–4108.